Laser-Flash Based Multiple Thermal Property Measurement Apparatus

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An apparatus has been designed and built at NPL for multiple thermal property measurement of solids in vacuum up to 1800 C. The design is based on extending the laser-flash technique for thermal diffusivity measurement but, without the use of coatings, to also measure specific heat capacity and emissivity. Previous attempts [1] at heat capacity measurement have often depended on the use of coatings of known emissivity but the temperature range was limited to about 1000 C.

The disc sample is mounted horizontally in vacuum, having minimal contact with its support. Following heating in a furnace to the required temperature, a cold shield is rapidly inserted around the sample front-face whereupon the sample begins to radiate freely and cool. Sample radiation at the laser wavelength (1064 nm) is recorded for a few seconds and the data smoothed to give the initial sample signal, I_0, which is then compared to that from a neighbouring blackbody cavity, I_B, to give the sample emissivity, $\varepsilon = I_0/I_B$. From Kirchhoff's law, the sample emissivity is equal to its absorptivity; so, by measuring laser power with a meter we can calculate the energy absorbed by the sample, Q_A, during a laser flash. From the observed temperature rise and modeling of heat flow through the sample, we obtain the specific heat capacity, C_p, from integration of $Q_A = m.C_p.\Delta T_c$, where m = mass and ΔT_c = corrected specimen temperature rise.

This paper describes the measurement principles and results obtained during commissioning of the apparatus.

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[1] Xue and R. Taylor, *Int. J. Thermophys*. **14** ,313 (1993).
[2] J. S. Redgrove, *High Temp - High Press* **17**, 145 (1985).